

# Effect of the dielectric layer on the transmission enhancement for metal hole arrays in terahertz region

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For the metal slabs perforated periodically with circular holes, the enhanced band-pass transmission characteristic has been observed. The mechanism of this phenomenon is attributed to the resonant excitation of the surface plasmon-polaritons (SPPs) at the metal-air (or dielectric) boundary. The SPP is not supported on the flat metal surface in the terahertz (THz) region because metals are regarded as a nearly perfect conductor in this region. However, the SPP-like mode is supported on the perforated metal surface according to Pendry et al. [1]. In this paper, we clarified the role of the SPP in the Pendry's sense in the enhanced transmission phenomenon for the metal hole arrays by measuring the effect of the dielectric film attached on the metal surface.

We used polypropylene films, the refractive index of which was 1.7, as the dielectric films and attached them on the output side of the metal surface. The transmission spectra have a characteristic peak which shift to the low frequency side with increasing the film thickness from 0 (no film) to 200  $\mu\text{m}$  as seen in Fig. 1. This result is ascribed to the decrease of the resonant frequency of the SPP excited on the output surface by the attachment of the dielectric film. The peak frequency shift shows a tendency of saturation in the thick region (Inset of the figure). Since the electric field of the SPP attenuates exponentially with going away from the metal surface, this result indicate that the SPP plays the very important role for the enhanced band-pass transmission property of the metal hole array.

[1] J. B. Pendry *et al.*, *Science* **305**, 847 (2004).

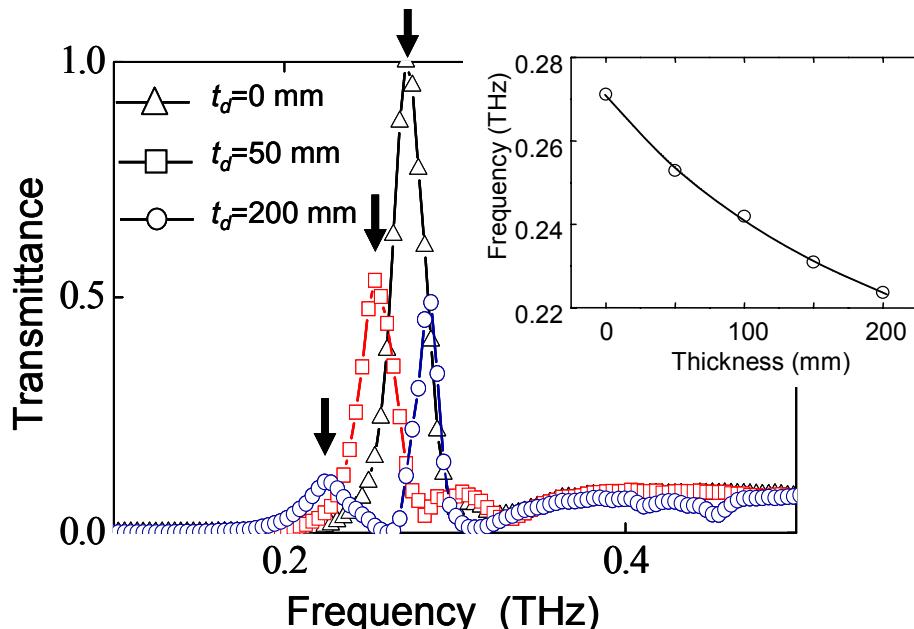


Fig. 1 Measured transmission spectra of the metal hole arrays for various film thicknesses. Inset shows the peak frequency as a function of the film thickness attached on the metal surface.